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ABSTRACT

The most common use of computers in distance education is in the preparation of a visual image that is somehow transmitted to students. This paper addresses some design considerations for computer-produced visual displays that are intended for either local or distant audiences. Advice is offered on all three basic components of information display: (1) creating a pleasingly structured image, including all the elements of screen design like the use of text, color, graphics, animation, and multimedia; (2) creating a meaningful display with graphs and other methods of data visualization; and (3) creating a powerful image, perhaps even with virtual reality techniques. (Contains 9 figures and 26 references.) (BEW)

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ENHANCING LOCAL AND DISTANCE EDUCATION WITH COMPUTER-PRODUCED VISUALS

by
Nancy Nelson Knupfer

ED 393 415

The increased capability and availability of computers for education has led to questions about the potential applications and impact of this medium on the teaching and learning process. The design of visual images can greatly promote or interfere with learning. Image design needs to consider several variables including, but not limited to, the audience and intended message, along with the medium and technological constraints.

When learners use computers on a local basis, they have opportunities to interact with the program. This interaction enables each learner to control the pace, length of a session, and path through the program (Jonassen, 1988). Distance education offers the ability to reach a larger range of students, but the technology often limits the type of interactive possibilities. Computers can be used to offer online instruction in both live and delayed modes. Audiographics and other types of shareware even can allow multiple users to manipulate the same screen image. But the most common usage of computers in distance education is in the preparation of a visual image that is then sent to the students by videotape, television broadcast, coded transmission, facsimile modem, or in print format by using facsimile or paper distribution systems. As computer-based multimedia products become more standardized, they too have a place in the distance learning scheme.

Ongoing improvements in computer hardware and software have removed some of the former technological barriers and now computers can supplement text with colorful graphics in both static and dynamic modes. Computer-controlled multimedia presentations can display images that are either digitized such as those on CD-ROM, or analog format such as those played from a videodisc. Some equipment even allows a mix of both analog video and digital displays on the same screen.

Because computer and television screens contain similarities, there are some design considerations that are common to both media. Presentations that mix images from a computer with images from a videodisc, television camera, or other projected image generally follow the rules of televised video screen design with some special consideration for the computer-based medium. This paper addresses some design considerations for computer-produced visual displays that are intended for either local or distant audiences. It assumes that electronically-produced instructional images require different design considerations than those that are limited to print.

Information display can be organized into three perspectives: the structure of the image, the meaning of the image, and the power of the image (see Figure 1). The structure of the image contains the essential elements of good screen design. These elements can enhance the learner's ability to perceive and interpret the intended message. This leads to the learner's ability to apply meaning within the given context. Finally, images add power to text-based messages; they have the potential to both clarify the message and add emotional impact.

Structure of the Image

The structure of the image first considers the visual as a whole, then its components and the elements of good screen design. In order for the various image components to work together, elements of well-planned screen design

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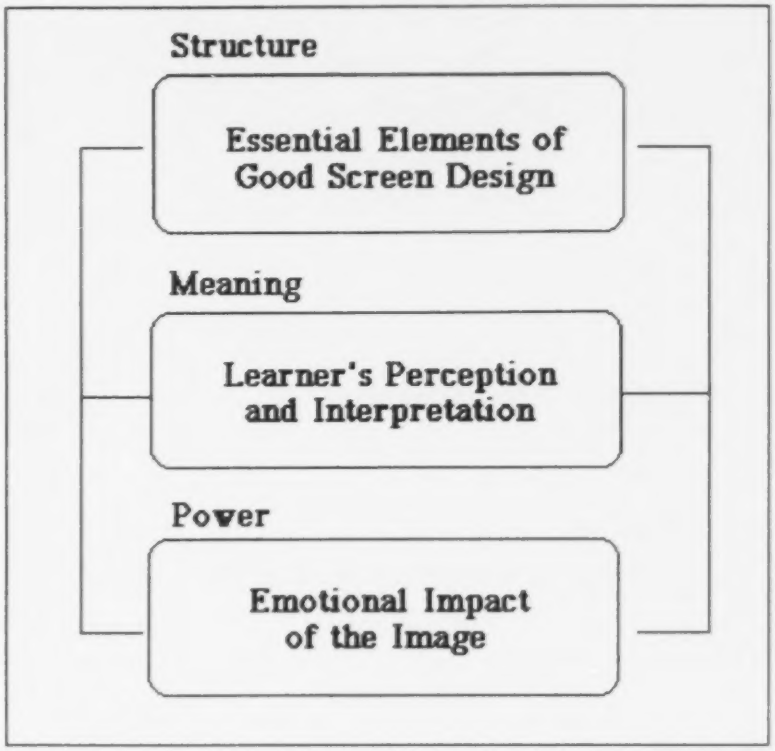
Figure 1. Effective Instructional Images



must weave the components together in an aesthetically pleasing and understandable format. Thus, one must consider both the image and the screen design.

The Image

The image contains a mix of components that can work together or separately to modify the intended message. As you read this section, try to visualize the possible image variations that result from influences such as text, color, graphics, animation, and multimedia.

Text

Since text dominates computer-based instruction (Soulier, 1988), it is important to design text displays that communicate clearly to the reader. With appropriate fonts and spacing, computer screens can work very well for presenting limited amounts of text. Large amounts of text work better in printed form (Soulier, 1988) since they induce eye fatigue (Hathaway, 1984; Mourant, Lakshmanan, & Chantadisai, 1981) and are likely to be forgotten when presented on the screen (Wager & Gagne, 1988).

In addition to the amount of text, its density, along with typographic cueing and the mix of upper-case and lower-case characters can affect legibility (Hartley, 1987; Hathaway, 1984; Morrison, Ross, & O'Dell, 1988; Ross, Morrison, & O'Dell, 1988). Variations in font type, size, and density along with direction and screen placement can add meaning to the text image (see Figures 2 and 3). With the exception of titles, headings, or special effects, the text should contain a mix of upper and lower case letters.

No matter what the screen design, legible text requires an appropriate font that is properly spaced. There is disagreement about the appropriateness of serif or sans serif style fonts. Some

authors claim that fonts with serifs, as opposed to block-style lettering, are a better choice for computer screens (Soulier, 1988). Yet others believe that sans serif fonts with proportional spacing provide a cleaner effect that is easier to read than their seriffed counterparts (Gibson & Mayta, 1992; Kemp & Dayton, 1985). Fonts with small serifs can add interest to the display, while elaborately-seriffed fonts are difficult to read, especially if the image is to be viewed on television or in a large room.

Text legibility also depends upon the point size of the font. The point size of text on a computer screen can range from 12 to over 100 points per inch and remain legible. However one should consider the intended usage when selecting point size. Images that are likely to be projected for large audience reading should not use a point size smaller than 26 (Gibson & Mayta, 1992) and images that are not likely to be projected or broadcast will seldom require an extremely large font. Also consider the user; when designing screens for young children or people with visual impairments, use a larger font.

In addition to style and size of the font, the weight of the typeface, line length, phrasing, and spacing between lines of text affect the legibility of computer screens. The weight of a font can vary from light, narrow, fine lines to heavy, broad, bold lines. A medium to bold weight is very good, depending upon the mix of elements on the screen. Gibson and Mayta (1992) recommend that bold typeface be used throughout all computerized screen images that are intended for broadcast so that the text shows up against the graphics. At the least bold fonts should be used for all titles and headings as well as for particular words that need emphasis. Drop shadows behind the text characters can add legibility if used carefully.

Because computers, monitors, software, and projection systems are becoming more capable, perhaps it is not as critical to adhere precisely to recommendations about font style and weight as it was in the past. An important contributing factor is the availability of good resolution provided by a VGA monitor and a quality projection device. Also, color can be provide visual cues within the text.

Color

Specific educational objectives can be enhanced by using color in visual illustrations (Dwyer, 1978), but while a few colors can cue the learner about the intended message, too many colors can be confusing. Color should assist the user in focusing on the material; it should never be a distraction (Gibson & Mayta, 1992). Accordingly, Hannafin and Peck (1988) suggest using a bright color to cue the learner for new information, while presenting the remainder of the information in standard colors consistent with the rest of the screen. Soulier (1988) recommends checking the program on a monochrome monitor and using a pattern as a backup technique to aid those people who are color blind.

Although this document is printed without color, Figure 4 shows an example of how color can be used to highlight menu choices. In part A, the learner sees that the *Child Development* module has five selections, with *Review* currently highlighted using a border color that matches the background of the *Child Development* box. Part B shows that the learner has single clicked the *Normal Development* topic and that box as well as the boxes of the newly revealed subtopic choices are now bordered in the highlight color. Highlighting the menu selections in this way can be particularly helpful in situations where there are many potential branches.

A few colors with good contrast values will show up well on both color or monochrome displays, but an extreme contrast like stark white on a black background will cause bleeding and illegibility; it is better to use light grey to achieve the desired effect. Also avoid high

Figure 2. Light and Airy Text

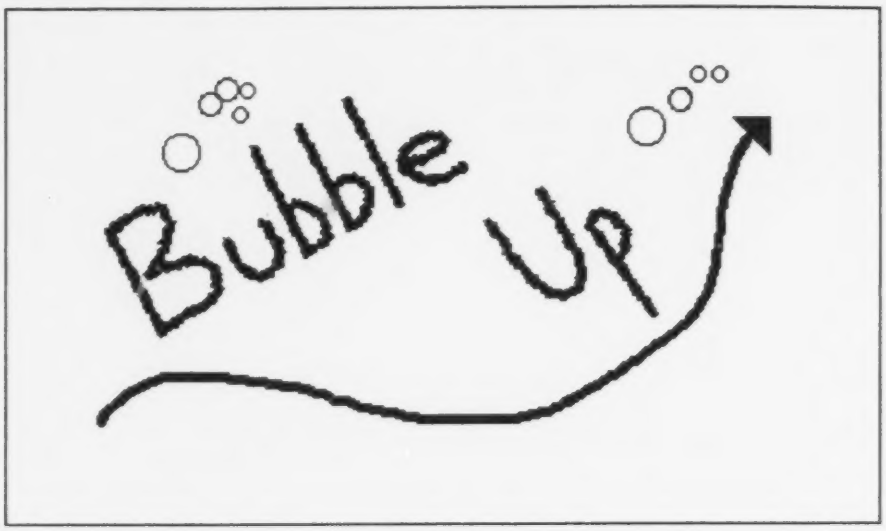


Figure 3. Bold, Forceful Text

values of red and orange because they can bleed into the surrounding colors.

In addition, certain colors that look ideal on an individual computer screen tend to flare or wash out when they are projected to a large screen or transmitted over a distance. To avoid disappointment it is best to experiment with a few color combinations using the equipment that will support the image when it is actually projected. Complementary colors with low saturation would have a good chance of working.

Graphics and Animation

Graphics add interest to the screen by providing visual variety (Kemp & Dayton, 1985) and offer another opportunity to suggest meaning to the learner. Possible graphic treatments range

from simple to complex, from small monochromatic embellishments to dramatic, richly-colored, full-motion video images complete with sound effects.

Like verbal metaphors, visual metaphors can help us to understand an unfamiliar concept. Metaphoric graphics (Soulier, 1988) may be used to clarify a meaning within the computerized message, or they can guide the user through the mechanics or functionality of using the software. For example, standard weather symbols might represent part of the content in a lesson about tornadoes while an exit sign icon would symbolize the functionality of the software.

Computer images are frequently transferred to other media such as transparencies, camera-ready art, computer-designed slides, animation, video segments, and so on. One type of graphic application that is regularly produced beyond the original computer screen is the common tabulated data graph. Graphs that represent data need to be clearly designed so the reader can interpret the meaning based upon the legend, scales, symbols, and other provided cues.

Graphs that display data depend upon the reader's thought processing, interpretation, and comprehension; to be effective they must consider the intended visual message carefully. Sophisticated graphic displays that are designed to suggest inferences, generalizations, and evaluative interpretation can help students interpret meaning (Reinking, 1986; Singer & Donlan, 1980). High-level instructional graphics, such as symbolic, schematic, or figurative displays can be effective in teaching, and the visualization of abstract ideas through figurative displays may very well enhance learning (Nygard & Ranganathan, 1983). All graphics do not require the same level of detail and clarity, but even simple, decorative graphics at the pictorial level have their place. Indeed, Boyle (1986) suggests a need for designers to address cognitive processes by developing more materials for graphic thinkers, not just graphic readers.

Figure 4A. Color Highlighted Menu, Part 1

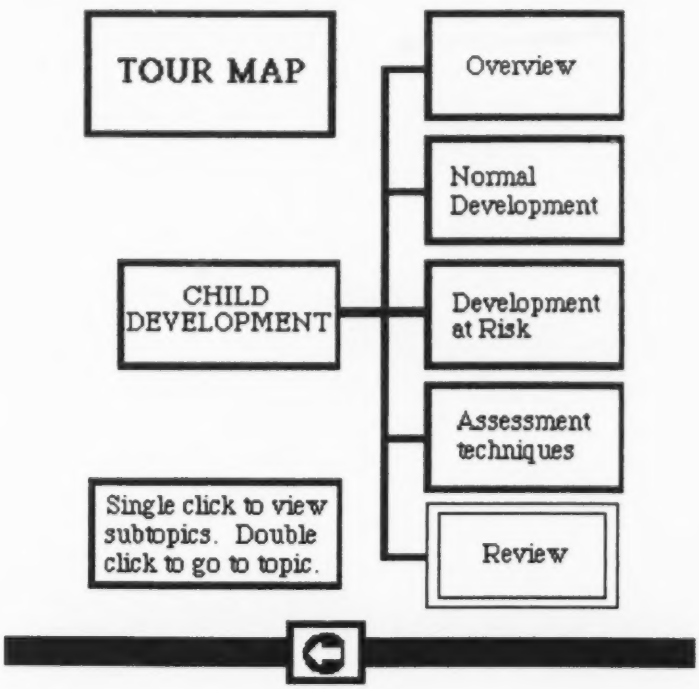
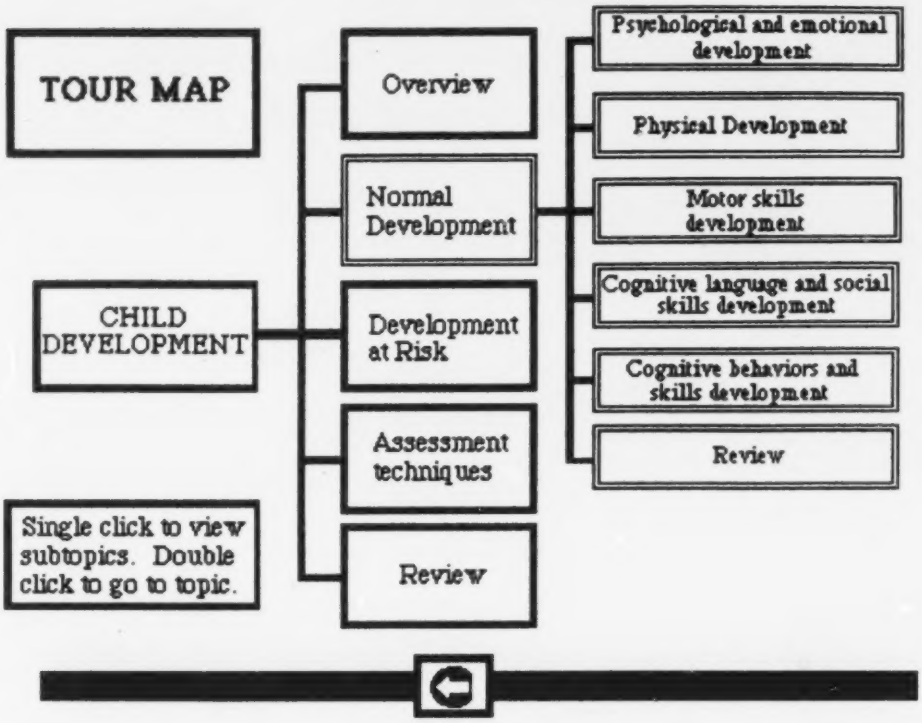


Figure 4B. Color Highlighted Menu, Part 2



To assist with designing computer graphics, Soulier (1988) offers the following guidelines: Keep illustrations appropriate for the audience; use simple line drawings when possible; preload graphics into the program so that they appear quickly on the screen; use standard symbols and symbolic representations; and keep graphics on the same screen in close proximity to the corresponding text message. These few tips can greatly improve the aesthetic appeal of a graphic and promote clarity of the message.

Most development software allows the use of simple animation to illustrate a motion, provide interest, or draw attention to particular areas of the screen (Kemp & Dayton, 1985). Although it is tempting to embellish the graphic, it is important to use animations only when appropriate and keep them short (Soulier, 1988).

Animate only a few graphics that will aid the learner's comprehension of the material by, for example, gaining attention or illustrating a concept. When used sparingly animations can be effective, but they can become irritating, distracting, or disruptive to the thought process if overused or left on too long. Whenever possible, allow the user to interrupt the animation.

Computer-Based Multimedia

Computer-based multimedia includes a wide range of possible delivery options, but is usually characterized by mixing video images with computer images. The possible styles range from single computer screen, to projected computer screen, to 360 degree *theater in the round* displays.

A currently popular instructional practice uses multimedia to support lectures with images from a videodisc or compact disc driven by a computer program. Despite its great potential for providing rich imagery and stimulating

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thought, this delivery method often falls short of expectations because of cluttered screens or inappropriate lesson delivery. One of the greatest problems in actual usage is the size of the text; the audience cannot read text from a distance unless it is enlarged. A second common problem is washed out colors in the computer graphics; color selection that does not hold up during projection. The general suggestions for computer screen design found below may be applied to various forms of multimedia displays as well as more traditional computerized images.

Screen Design

Good screen design aids the learner by using visual components to portray the message in a way that provides both clarification of information and visual interpretation. To visually aid the learner, it is necessary to consider the specific elements of good screen design as well as the general screen layout.

Elements of Good Screen Design

Interesting screens are composed of a variety of elements that work well together. Many of these elements are equally important so they are presented here in no particular order. The goal of good screen design is to use the various elements together to compose a simple, consistent design that provides sufficient information while avoiding clutter.

Unlike printed material which can be skimmed at will, the computer screen limits the learner's view of the overall content. Screen designs that are simple, straight forward, and consistent can help lead learners through the material, while complicated designs can lead to frustration. The basic simplicity of frame layout and user options does not restrict the ability to add interest and meaning with a full range of simple and complex graphics.

Certain user options should always be available. For example, status lines at the top or bottom of the screen that contain consistent information help the learner assess progress and maintain some control over the program direction. The reader should control the display rate when possible so that there is adequate time to read the text, interpret the graphics, and consider the meaning of the message.

Menus should be clear, concise, uncluttered, and consistent. Icons within menus can be very helpful if the meaning of the icon is readily apparent. The range of possible choices in some programs can lead to cluttered or excessively layered menus; pull-down menus can be a solution. Highlighting or fading some menu choices will quickly give a visual cue about which items are currently available.

Careful positioning of text on the screen can add to its aesthetic appeal and legibility. Although centering can work for lists, diagrams, or graphic mixes, most text should be left justified and limited to 65 characters per line or 25 characters per line for projected images. Partitioned screens in which text is confined to specific areas, can work very well.

Ross and Morrison (1988) suggest using a hierarchical text display that is vertical and uses indentations similar to an outline. They further recommend a low-density text display with reduced wording and sentences limited to one main idea. It it also important to use care when splitting lines so that phrases remain complete Soulier (1988). Personal preference varies concerning single or double spacing of text, but do provide text breaks where the content allows.

In addition to font size, the text legibility is influenced by contrast with the background. Common considerations for both computer screens and video images suggest cool, neutral background colors like grey or blue instead of bright, very light, or very dark backgrounds. Tasteful use of enhancements such as outlined, inversed, flashing, or drop shadowed text can add to legibility.

Special techniques for changing the screen display, such as zooming, panning, tilting, and wiping onto the screen, can vary the viewer's perspective of the image. For example, a section of the screen can be enlarged to give a close-up view of specific details. Or the image can change from a long shot displayed in a small part of the screen to an extreme close-up showing part of the same image displayed in full screen mode. This technique can give the learner the sense of moving in to take a close look at the image. Imagine, for example, the visual effect of looking at a long shot of a group of trees in a small box on the screen and then changing to a full screen display of a close-up shot of leaf on one of those trees.

When broadcasting computer graphics for distance education, overscan and underscan considerations become important. Overscan fills the screen beyond the edges so that no blank space will show around the edge when the image appears on a television monitor; computer graphics need to be produced in overscan mode so that no blank edges or distracting video signals will show around the edges during transmission (Gibson & Mayta, 1992). Underscan protects a blank area around the screen edge so that images don't get cut off during the transmission process; important information should be placed within a safe area, usually the middle two-thirds of the screen (Kemp, 1980). It is important to pay attention to both overscan and underscan because the desired result is neither an empty pocket around the around the screen nor loss of important information around the edges. One way to handle overscan and underscan variations is to use a border around screen; this fills the screen edge completely while marking the safe area.

Screen Layout

The elements of good screen design work together to build a cohesive screen layout. The computer screen layout should never be visualized as a printed page filled with text, but guidelines similar to those offered for desktop published materials can be helpful. These include balancing text with white space, improving the aesthetics of the page, and positioning graphics as the dominant visual element (Parker, 1987). Designing the display with attention to legibility, the purpose of the particular frame, and consistent protocol, can result in visually interesting computer screens. Avoid cluttering the screen with too many images; provide print copies of complicated images that are important to remember.

Like silence within oral communication, empty spaces can be used to advantage on the computer screen. For example the screen can be used to organize or highlight information, to draw attention to particular parts of the frame. The mix of graphics and text can provide a visual cue; so can boxing and grouping of information. Partitions, borders, standard icons, and consistent placement of common elements will visually aid the reader.

While partitions and borders can draw attention to an area, artistic sense can still flourish. Figure 5 shows a screen layout that protects a bordered area for graphics where the designer has incorporated two borders, one within the other. The image is allowed to overflow the internal border while being contained by the external border.

Generally headings are centered and bold, sometimes even boxed. For long or complicated sequences, subheadings can be used that include numbers or Roman numerals to aid the reader in visually following the general flow of information. As a general rule, information should flow from the top, left part of the screen to the bottom, right part of the screen because that is the way people in our culture read. Figure 6 shows artistic variation that splits a title between the top and the bottom of the screen. Because the information flows from top left to bottom right, this title works. It also provides a subtle hint to the reader about the program content; both the title and the quilts discussed in the

program must be pieced together to make a whole. Variations in standard layout can work if they are with purpose and fit the situation.

Good layout technique depends upon an understanding that not all computer frames are alike. Hannafin and Peck (1988) address transitional, instructional, and question frames. Transitional frames are used to tie together the different parts of the a computerized lesson: they provide an orientation to the beginning of, and various sections within, the program; they serve as bridges between various topics or sections; they provide feedback, directions, and instructions; and periodically, they present a progress report to let the learner gauge success. Instructional frames present basic information to the learner: these frames can alert the student to a need for prerequisite information; provide links between relationships from past and current learning; and provide definitions, examples, and rules. Question or criterion frames solicit input from the student to help individualize the instruction; these frames usually are based upon a true or false, yes or no, multiple choice, completion or short answer, or a constructed response which is considered to be a more open-ended answer.

There are also variations to the general type of frames. For example, sometimes a frame contains both instruction and a question. Copy frames, prompt frames, hint frames, and interlaced frames are some types of variations (Hannafin & Peck, 1988). Copy frames provide information and a question about that information in the same screen. This type of format can be helpful in directing student attention, emphasizing important points, and for assuring a high degree of success for particular students. But because they are so obvious, copy frames are considered very elementary and need to be used sparingly.

Prompt frames direct the learner to supply input; these can be used effectively for questions as well as instructional screens. Hint frames are usually provided after a student has failed to enter an expected response; they offer guidance but do not supply the correct response. Interlaced frames are hybrids which combine various components from the

Figure 5. Partitioned Frame with Double Bordered Graphic

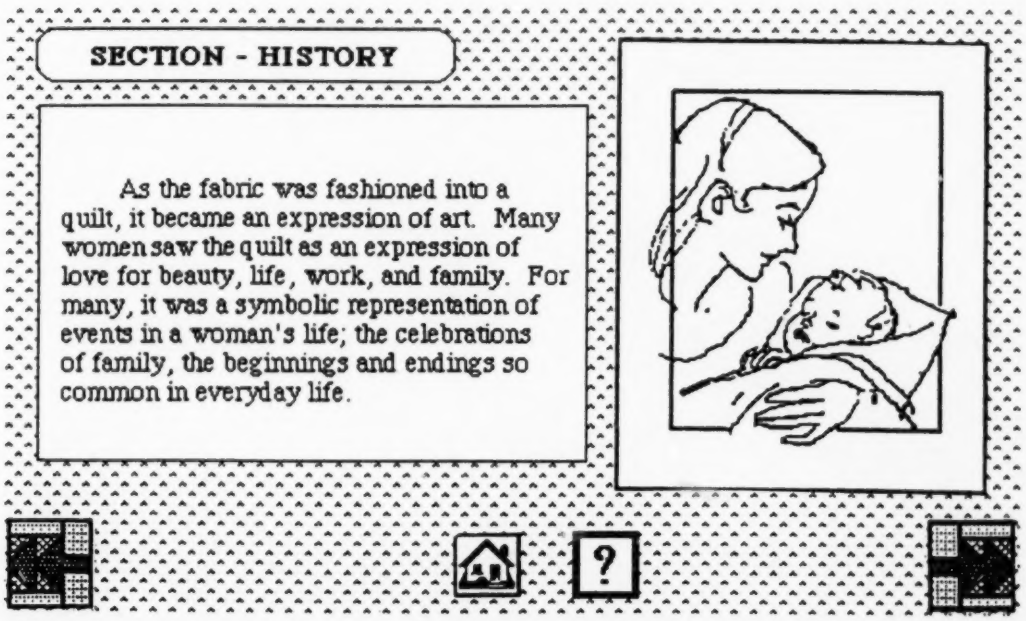
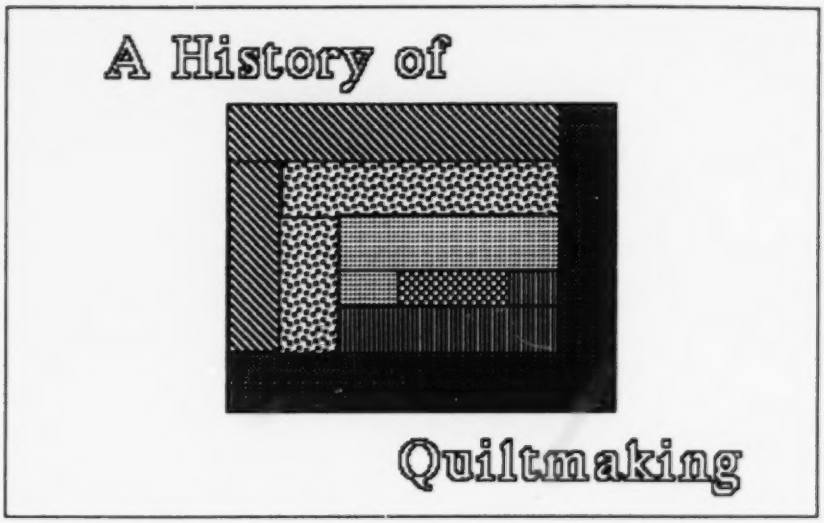

SECTION - HISTORY
As the fabric was fashioned into a quilt, it became an expression of art. Many women saw the quilt as an expression of love for beauty, life, work, and family. For many, it was a symbolic representation of events in a woman's life; the celebrations of family, the beginnings and endings so common in everyday life.
?

Figure 6. Left to Right Title Split:



standard frame types; they might include instruction, question, and feedback all on the same screen. This design can appear cluttered if not presented carefully but it has the advantage of allowing the student to visually examine and compare the question and feedback.

Each type of frame depends upon grouping of information in a way that visually aids the reader. To make optimal use of visual cues, it is helpful to design standard protocol for each type of frame and use it consistently throughout the program. Whatever protocol is chosen will need to comply with the overall program design. Programs that vary the screen location of pertinent information or procedures used to advance throughout the program can be confusing and frustrating (Mackey and Slesnick, 1982). Although standard protocol is necessary (Heines, 1984; Lentz, 1985; Simpson, 1984) designers can provide artistic variation to other parts of the screen to suggest meaning.

Meaning of the Image

Information becomes valuable as it takes on meaning for an individual. Since visuals are meant to aid in the discovery of meaning, it follows that well-designed visuals will help students interpret the meaning. Computer images vary widely in potential design and usage. Images can be static or dynamic, concrete or abstract, and they can change as a result of user interaction with the program. A learner's interpretation of the image can be affected by the text, type of graphic, and layout employed.

Layout must consider the principles of perceptual organization, which include similarity, proximity, continuity, and closure (Bloomer, 1976). These four processes, by which the mind organizes meaning, depend on how physically close the objects are, how similar they are, whether there is a continuous line to guide the eye, and whether the minimal amount of information is present that is necessary to obtain meaning or closure. Comprehension is directly affected by the way the mind organizes meaning from the placement of graphics and text.

Creating Meaningful Data Displays

Since powerful computers and software are now available to many people, the practice of transforming numerical data into visual displays is no

longer limited to trained professionals. It follows that some design guidelines are needed.

Graphs

There is a wide selection of software that produces graphs to tabulate or represent data. These data displays can take the form of circle or pie graphs, bar or chart graphs, line graphs, histograms, and scatterplots, among others. The ease of creation does not always result in good, meaningful graphics. It is important to follow some common sense approaches to graphical data display, whether the information is to be used on or off the screen, locally, or at a distance.

It is tempting to use various software features to make elaborate and colorful graphs, but in reality simple is better when displaying data (Tufte, 1983). To help learners interpret the meaning of graphs, use only those dimensions and colors that are necessary to convey the message; three dimensional graphs should only be used when the third dimension represents a third aspect of the data interpretation, and color should only be used for contrast as an interpretational aid. To help illustrate the point, two poor graphs and a better graph are provided, each presenting the same information in a different way.

The three graphs all illustrate the rate of ticket sales at Kansas State University (KSU) over the last twenty years. The horizontal scale reflects two-year intervals and the vertical scale shows increments of 5,000 tickets sold. Figure 7 displays the original graph printed in a local newspaper (Seaton, 1992). It is cluttered, numerals are redundant, the horizontal scale is inconsistent, the title is within the graph, the legend is scattered throughout the data, and the accompanying article disagrees with the displayed information (the full text of the article is not contained here, only the title). The caption below the graph appears to be not centered but that is not a flaw; it is the title of the accompanying article in its original placement on the newspaper column. The reason that it appears here is because it does not match the information provided in the graph. Both the title and text of the article claim that football ticket sales have increased for the 1992 season over the 1991 season. However there is no data provided for the rate of 1992 ticket sales within the graph nor within the article.

It is confusing that the graph goes out of its way to vary the horizontal scale, yet omits 1992 information. This scenario demonstrates a typical example of unusable information that was meant to enhance an article. In practice, the reader sifts through visual clutter only to find that the comparative information is missing in the end.

Figures 8 and 9 provide alternate displays to the same information. Figure 8 employs the very popular three dimensional display in which the third dimension is meaningless. Figure 9 is not perfect, but it presents the three pieces of information in a way that can be interpreted from the visual pattern. It is an improvement over the original graph presented in the newspaper, but still omits necessary 1992 data which remains a mystery.

The critical point is that visual information is frequently misrepresented by lay people who produce data graphs without the benefit of proper guidance. This practice can be dangerous since it can confuse and mislead consumers. Computers are not responsible for poor visual design, but they make it possible for uninformed users to produce inadequate products.

Data Visualization

Data visualization is a way displaying information as an image instead of a series of numbers. It allows data from scientific events to be visualized in a symbolic, pictorial way that can seem more understandable to the lay audience and to professionals who prefer to interpret data visually as opposed to

numerically. For example, digitized computer imagery can show a tornado in action. The visual display of the tornado's dynamics allow scientists to study the patterns of wind, motion, and behavior of tornados in a way that could only be interpreted before from numerical recordings. Some other examples of data visualization include: symbolic imagery about atmospheric conditions from other planets, that has been collected via satellite measurements; visual display of data collected from a physics experiment, such as data points that represent the upward and downward trajectory of a ball as it is tossed into the air from a moving object, travelling at a certain speed; visual display of possible outcomes of automobile accidents occurring between a certain number of automobiles with specific characteristics, travelling at a particular speed under given road conditions, etc. This last sort of visual information could be used to solve mysteries about how particular accidents happened for law enforcement or insurance purposes, or it could be used by automobile manufacturers who seek to design safer vehicles.

Data visualization displays images of an event in action while standard types of graphs display patterns of numerical information resulting from the event. Even though the general public can better understand a data visualization than a set of numbers, the method is controversial because some scientists question its accuracy for displaying scientific data. These objections are not necessarily well grounded, but most likely reflect a set of values that fear removal of the traditional professional skill required to interpret the standard numerical data.

People need to know that there is something in between the two extremes of data visualization and lists of numbers; in the middle lie the various common graphs that so many people have come to rely upon. However, those graphs are limited in the type of information they can accurately display, particularly when motion and various dimensions are involved.

Power of the Image

Computer graphics and appropriate screen displays lend power to communications by adding an image to the text. Visual images can aid message interpretation and enhance learning. They can also add power to the message by providing an emotional element that is beyond that of other communication strategies. Realism can be enhanced by providing a graphic component. Images can represent realistic data ranging from simple sketches or graphs to intricate displays or vividly emotional scenes. Virtual reality can even conjure up imaginary situations through artificial imagery.

Because computers display images from peripheral devices, it is possible to display still or dynamic photos of real events. These events and their results can combine with text and audio segments to provide a sense of realism to the user that otherwise would not be possible. For example, the ABC News videodisc provides real news footage that goes beyond newsroom reporting to provide visual displays of field events. Along with the understanding provided by the realism of these events, comes the potential to stir emotions for various reasons.

Going Beyond Reality

Virtual reality offers the opportunity to remove a person from the real environment and create a feeling of living within an artificial mode. Some examples of this sort of application include specific video arcade games, airplane simulators, and architectural design software in which the user's actions are reflected visually within the software display.

Within virtual environments created by the computer, participants become part of the software environment and feel as though they are within the computerized image that is displayed. Rather than

viewing the image from without, the participants change perspective and view the image from within the software.

For example, arcade games in which the player becomes part of the game, as opposed to manipulating the game as a viewer, employ virtual reality. Instead of manipulating a lever and observing the result of its movement on a screen-displayed baseball game, the player might wear a viewing device over the eyes and a manipulative device such as a data glove to control a particular action within the game. The viewing device limits the player's view to the three-dimensional image of the game and the data glove produces simulated movements within the game based upon a realistic motion of the player's hand or arm, such as throwing a ball. This produces the feeling of actually playing the game.

Virtual reality is used within high-class pilot training in which the trainee obtains the feeling of actually flying the aircraft. Placed within a simulated cockpit the realistic knobs, switches and levers (pilot control devices) become the input devices, while the flight control panel and the windshield become the viewing devices where the pilot observes the effect of control movements. Not only does the control panel light up appropriately, but its gauges reflect the trainee's actions at the flight controls, while the control panel displays various maps of the flight path and even simulates a radar screen. All the while, the pilot views the surroundings through the simulated windshield and can observe other airborne craft in the immediate area as well as the appropriate ground activity based upon the altitude, speed, weather conditions, and general visibility being simulated. This type of pilot training usually progresses in stages from standard classroom training, to traditional computer-based training, and then on to the flight simulator for the artificial practice flight, prior to engaging in a training sortie in a real aircraft.

The third virtual reality example, architectural software, produces the ability for the common consumer to obtain the feeling of entering and moving around within an environment prior to its actual construction. A good example of this type of application is a department store which creates custom-designed kitchens. A customer can don a viewing helmet and a body movement probe in order to try out a new kitchen prior to its actual construction. Sophisticated software allows the customer to try different room arrangements while doing such things as stretching to reach the highest shelf or testing the comfort of the counter height and drawer positions.

These virtual environments are digitized images that not only display information to the visual senses, but allow the user to participate in the resulting display by contributing other communication strategies such as movement or speech. You can imagine that such images can get very complicated and can stray from the standard rules of computer screen design. Certainly artificial reality opens new doors for visual communications with computer input and display devices.

Summary

Structure, meaning, and power combine to produce effective instructional images that can be created on computers. The structure of the image considers both the components of computer images and the elements of good screen design; the interworkings of both produce effective instructional displays.

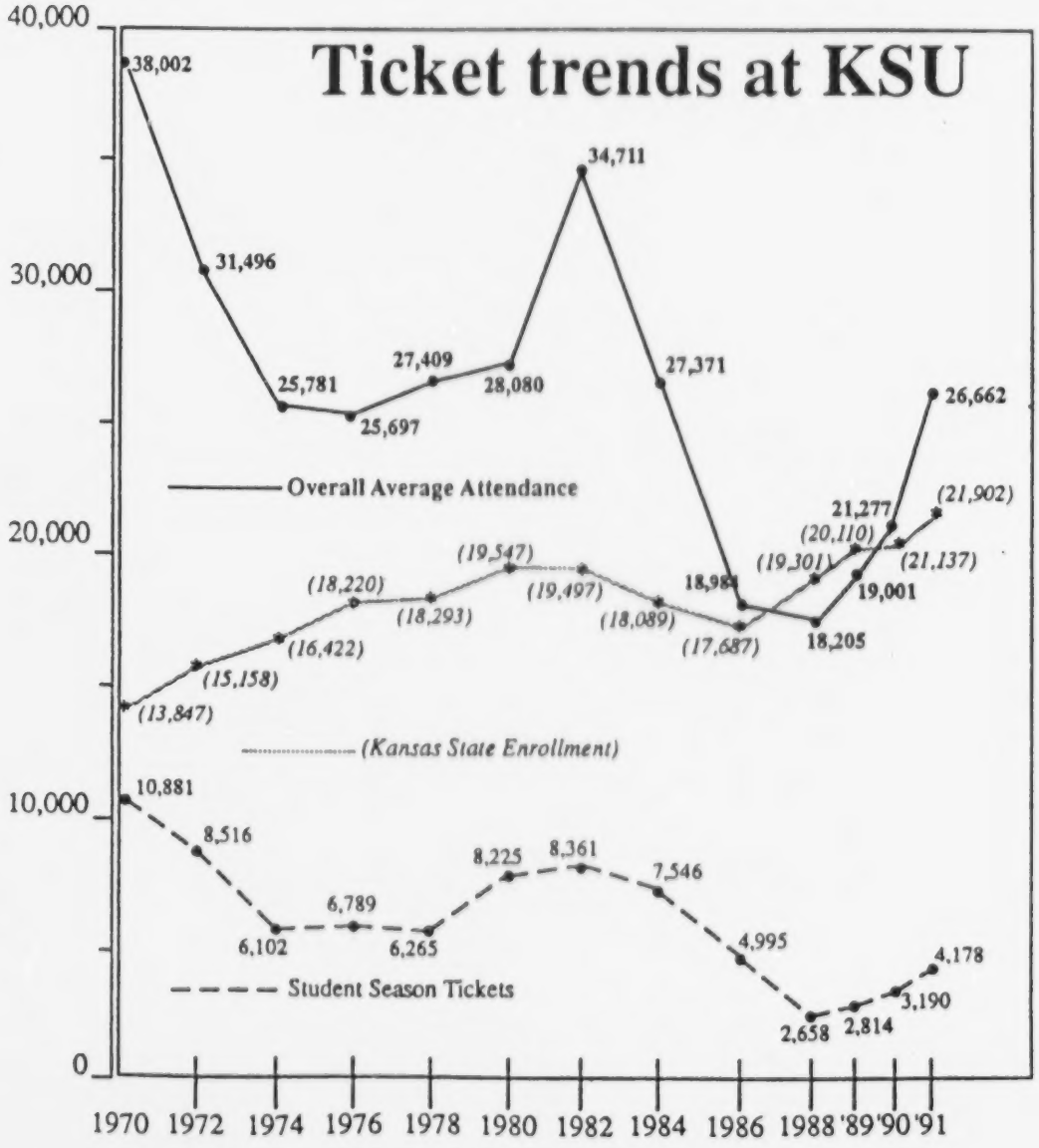
New levels of knowledge, a variety of media options, and sophisticated software, offer the ability to improve computerized images and their resulting products. Although text remains a very important part of computer communications, today's technology encourages the use of more more graphics.

Visual communication combined with sound cognitive strategies can provide meaningful messages for learners. In order to provide meaning, computer

graphic displays need to follow some rules of good design.

Understanding and emotional impact can be enhanced through powerful computer imagery. The imagery can represent real situations or it can create an artificial situation that appears to be real. Today, artificial reality remains limited to a small set of applications and is accessible to a restricted range of people, yet its future potential is tremendous in terms of visual communications and educational impact.

Figure 7. Cluttered Graph



Ticket sales show increase over 1991

Figure 8. Graph with Excessive Dimensions

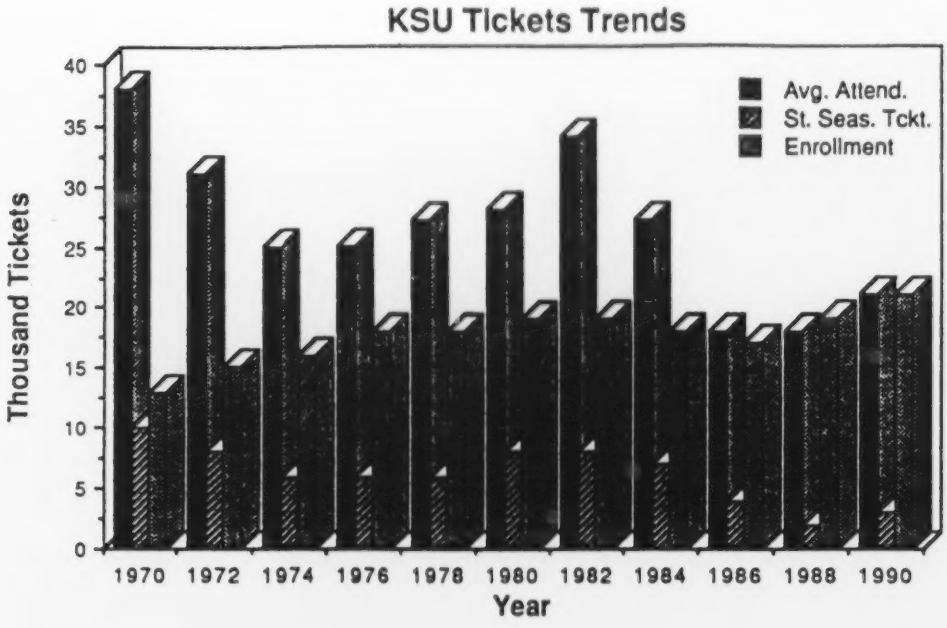
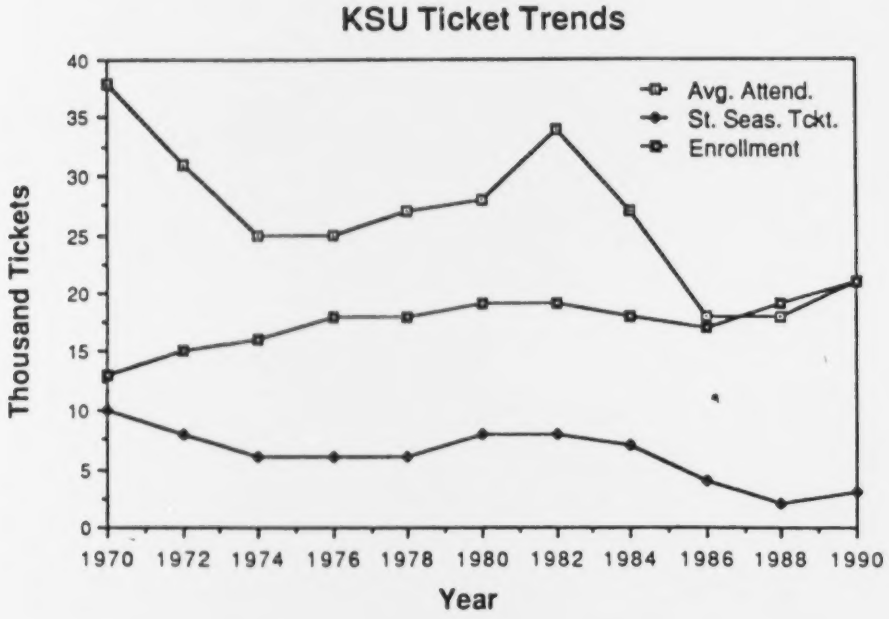


Figure 9. Line Graph



References

Bloomer, C. M. (1976). *Principles of visual perception.* New York: Reinhold.

Boyle, M. W. (1986). Hemispheric laterality as a basis of learning: What we know and don't know. In G.D. Phye & T. Andre (Eds.), *Cognitive classroom learning: understanding, thinking, and problem solving.* San Diego, CA: Academic Press.

Dwyer, F. M. (1978). *Strategies for improving visual learning.* State College, PA: Learning Services.

Gibson, R. & Mayta, M. (1992, August). *Designing computer-based instructional graphics for distance education.* Paper presented at the eighth annual conference on Distance Teaching and Learning. Madison, WI.

Hannafin, M. & Peck, M. (1988). *The design, development, and evaluation of instructional software.* New York, NY: MacMillan.

Hartley, J. (1987). Designing electronic text: The role of print-based research. *Educational Communication and Technology, 35*(1), 3-17.

Hathaway, M. D. (1984, January). Variables of computer screen display and how they affect learning. *Educational Technology*, 7-11.

Heines, J. (1984). *Screen design strategies for computer-assisted instruction.* Bedford, MA: Digital Press.

Jonassen, D. H. (1988). *Instructional designs for microcomputer courseware.* Hillsdale, NJ: Lawrence Erlbaum.

Kemp, J. (1980). *Planning & producing audiovisual materials* (4th ed.). New York: Harper & Row.

Kemp, J., & Dayton, D. (1985). *Planning & producing instructional media* (5th ed.). New York: Harper & Row.

Lentz, R. (1985). Designing computer screen displays. *Performance and Instruction, 24*(1), 16-17.

Mackey, K. & Slesnick, T. (1982). A style manual for authors of software. *Creative Computing, 8*, 110-111.

Morrison, G. R., Ross, S. M., & O'Dell, J. K. (1988). Text density level as a design variable in instructional displays. *Educational Communication and Technology, 36*(1), 103-115.

Mourant, S. J., Lakshmanan, R., & Chantadisai, R. (1981). Visual fatigue and cathode ray tube display terminals. *Human Factors, 23*, 529-540.

Nygard, K. E., & Ranganathan, B. (1983, Spring). A system for generating instructional computer graphics. *AEDS Journal, 16*(3), 177-187.

Parker, R. C. (1987). *The Aldus guide to basic design.* Seattle: Aldus Corporation.

Ross, S. M., Morrison, G. R., & O'Dell, J. K. (1988). Obtaining more out of less text in CBI: Effects of varied text density levels as a function of learner characteristics and control strategy. *Educational Communications and Technology Journal, 36*(3), 131-142.

Reinking, D. (1986). Integrating graphic aids into content area instruction: The graphic information lesson. *Journal of Reading, 30*(2), 146-151.

Ross, S., & Morrison, G. (1988). Adapting instruction to learner performance and background variables. In D. H. Jonassen (Ed.), *Instructional Designs for Microcomputer Courseware* (pp 227-

245). Hillsdale, NJ: Lawrence Erlbaum Associates.

Seaton, J. (1992, September 4). Ticket sales show increase over 1991. *The Manhattan Mercury*, 7.

Simpson, H. (1984). A human-factors style guide for program display. In D. F. Walker & R. D. Hess (Eds.), *Instructional software: Principles and perspectives for design and use.* Belmont, CA: Wadsworth.

Singer, H., & Donlan, D. (1980). *Reading and learning from text.* Boston, MA: Little, Brown.

Soulier, J. S. (1988). *The design and development of computer based instruction.*. Newton, MA: Allyn & Bacon.

Tufte, E. (1983). *The visual display of quantitative information.* Cheshire, CN: Graphics Press.

Wager, W., & Gagne, R. (1988). Designing computer-aided instruction. In D. H. Jonassen (Ed.), *Instructional designs for microcomputer courseware* (pp 35-60). Hillsdale, NJ: Lawrence Erlbaum Associates.